PE&RC PhD PROJECT PROPOSAL

Please read the appendix with instructions first

1. GENERAL PROJECT INFORMATION	
Main PE&RC affiliated Institute / University	Wageningen University and Research (WUR)
Main PE&RC research group	Plant Production Systems (PPS)
Other PE&RC groups involved	/
Project Title (English)	Farmers' choices in applying agroecological intensification options in the light of farming risk in southern Mali
Project duration	FROM 1/12/'16 TO 30/11/'20
Where will the research be conducted (country)	The Netherlands / Mali
At which University will the thesis be defended?	WUR
Funding source(s) for this project (1, 2, or 3?)	1 (internal) / ~~2 (NWO)~~ / 3 (external) (strikethrough) Name of funding source: McKnight Foundation

2. THE PhD CANDIDATE	
Full name of the PhD candidate	Eva Katrien Huet
Gender	FEMALE
Nationality	Belgian
Date of birth	21/04/1985
Period of appointment	FROM 1/12/'16 TO 30/11/'20
Hours per week	40

3. SUPERVISION

Project role	**Name + title**	**Specialisation**	**Organisation**	**Hours/week**
Promotor	1.Prof. Dr. Ken E. Giller	Farming Systems Research	PPS	
Daily supervisor	1. Dr. Ir. Katrien Descheemaeker	Crop-livestock systems, modelling and participatory approaches	PPS	
Advisor	1. Dr. Myriam Adam	Agronomy, field experiments and modelling	CIRAD	
Technician	1. 2.			
Other	1. 2.			

4. COLLABORATION

Type of organisation	**Name of organisation**	**Name + title of collaborator(s)**
University	1.WUR	
Research Institute	1. ICRISAT 2. CIRAD	Myriam Adam
Government agency	1. IER	Ousmane Sanogo
Others (e.g., FAO,WHO)	1. AMEDD	Ousmane Dembele

5. ETHICS	
Will vertebrates be used in animal experiments?	NO
Are there other ethical issues to be considered with respect to this project?	NO
If YES, please elaborate:	

PE&RC PhD PROJECT PROPOSAL

In case a peer-reviewed full project proposal is available (e.g., NWO or EU), please send that proposal along together with the reviewers comments and the acceptance letter.

6. SUMMARY (250 words (max. 250))

Agricultural activities are the main source of income for households in the cotton zone of southern Mali. This agricultural system is pressured by increasing climatic variability and demographic growth. Agroecological intensification (AEI) is seen as a promising pathway to increase food production, to be resilient to climate stress, without causing environmental degradation. Past research tailored AEI options to farm types, but did not yet consider intra-household dynamics that influence decision making. Furthermore, the adoption of new technologies is not only guided by profitability but also by the perceived risks of their use, and hence adoption rates are often disappointing.

This research focuses on the choices farmers make about the use of AEI options, and the performance of these options, in the light of the different risks farmers are facing. Both diversity within farms and among farms will be considered, since differences in constraints and opportunities might lead to other management strategies. Understanding these dynamics generates suggestions to inform farmer decision making, and insights for participatory research for development projects.

Survey information is combined with farm observations and trials, based on the DEED (Describe, Explain, Explore, Design) framework. Every season on-farm trials and demonstration fields are designed jointly by researchers and farmers to assess performance of AEI options according to several criteria. The results are discussed in village meetings, to stimulate co-learning. This data, and data from similar trials in previous years, is used as input in ex-ante modelling tools simulating performance of AEI options in an environment subject to risks.

7. DETAILED DESCRIPTION OF THE RESEARCH PLAN (2500 words (max. 2500) + 1 page literature list)

Problem statement and background

In the cotton zone of southern Mali, agricultural activities remain the main source of income for households (Losch et al., 2012). Apart from generating income, the main objective of these farmers is to sustain their food self-sufficiency with the cultivation of maize, millet and sorghum (Bosma et al 1999). However, crop yields are stagnating and labour productivity has decreased since the nineties (Falconier et al., 2015; Aune and Bationo, 2005). During this period only a minority of farms (17%) simultaneously improved crop yield, labour productivity and food self-sufficiency status (Falconnier et al., 2015).

The agricultural system is confronted with several pressures. Mali already experiences irregular rainfall patterns, and climate variability is expected to increase further. This change in climate is a threat for agricultural productivity and growth (Andrieu et al., 2017). In many areas of West Africa, including Mali, demographic growth led to the decrease of long-duration fallow periods (Andrieu, et al., 2015; Traore et al., 2015), which implies less and degraded rangelands for livestock, declining soil fertility and thus impairing crop yields. Also, demographic growth goes hand in hand with increasing demands for food, feed and fuel (Herrero et al., 2010), enlarging pressure on natural resources.

This demographic pressure and climate threat ask for adaptation in smallholder farming systems (Douxchamps et al., 2016). Agroecological intensification (AEI) offers options to intensify food production and be resilient to climate stress, without increasing pressure on the natural environment (Vanlauwe et al., 2014). Wezel et al. (2015) defined AEI as “improving the performance of agriculture while minimising environmental impacts and reducing dependency on external inputs through integration of ecological principals into farm and system management”. Past research has already proposed a range of AEI options for the region, depending on the resource endowment of the farm type (‘best-fit’ options).

These options include, amongst others, avoiding delay in planting (Traore et al., 2017), integration of crop and livestock production components (Sumberg, 2013), targeting crops to a given soil type and place in rotation, diversifying crop choice with soybean and cowpea, maize-cowpea intercropping for crop-livestock farmers (Falconnier et al., 2015), or stall feeding of livestock during the dry season (De Ridder et al., 2015; Falconnier et al., 2017).

Nevertheless, adoption of new technologies by Sahelian farmers is not only guided by yield-enhancement and profitability of these technologies but is often limited because of e.g. financial constraints, labour shortages and perceived risks that come along with the use of it (Schlecht et al., 2006). The risks of farmers are related to drought, pest attacks and variable prices (Schlecht et al., 2006; Aune and Bationo 2008).

Depending on the resource endowment of the farm, different AEI options may be relevant. Therefore, farms are often classified according to their available resources when searching for ‘best-fit’ AEI options (e.g. Tittonell et al., 2010; Falconnier et al., 2015). However, the variability of resource endowment within a farm is generally not taken into account in these studies. Particularly in Mali where households are complex entities, larger than just the nuclear family, this is an important omission.

In this region, access to resources, constraints and opportunities vary between the different household members (Guirkinger and Platteau, 2013). For example, allocation of individual fields to family members may differ between men and women (Paresys et al., 2016). Goetgebuer et al. (2011) found that yields on individual (male) plots were higher than yields on the plots collectively cultivated. Understanding intra-household variability may help to explain the socio-ecological context of smallholder farming to which AEI options need to be tailored in order to foster their adoption.

Risk management strategies also vary between farms and within farms, and are important to take into account when analysing why farmers (don't) adopt certain options. The strategies that farmers apply, depend on how they perceive risks, and the production risks they face. Risk can be defined as the probability of harmful consequences resulting from the interaction between a hazard (i.e. probability of occurrence of certain events), exposure (farm presence in the area where the events might occur) and vulnerability (i.e. propensity of exposed elements to suffer adverse effects when impacted by an event) (Cardona et al., 2012; Carrão et al., 2016). The strategies farmers apply to spread their risks is expected to affect farm performance.

An AEI option mitigates risks when it increases production or reduces farm losses compared to other practices, when faced with a change or shock in the production environment. Risk mitigation is believed an important decision factor for farmers (Schlecht et al., 2006). Some possible risk management strategies from literature are (i) generating income from off-farm sources (Douxchamps et al., 2016), (ii) adapting planting date (Traore et al., 2014), (iii) maintaining crop diversity (Berti and Jones, 2013), keeping livestock (Valbuena et al., 2015), (iv) having fields for shared and individual production within a household (Guirkinger and Platteau, 2013) or (v) adapting the choice of crops targeting the expected harvesting time to the seasonality of cash need (farmers input during planning meetings, April 2017). We lack thorough understanding of the risk mitigating potential of these strategies.

Douxchamps et al. (2016) stress the importance of understanding households' coping strategies and decision-making processes in the process of tailoring a set of adaptation strategies in a changing environment and climate variability. By unravelling the diversity between and within farms, and households' risk management strategies, this research will contribute to better tailoring of AEI options with the aim to increase adoption likelihood.

However, the mechanisms of adoption and adaptation of AEI options by smallholders are complex and not yet fully understood (Glover et al., 2016). In Koutiala, co-learning between farmers and researchers was initiated in 2013 (Falconnier et al., 2017) and still continuing. How farmers take on board new knowledge - what options they adopt and how they adapt them - is the next step in this research. According to Douthwaite and Hoffecker (2017) the impact of a research project depends on a pathway of technology adoption and a pathway of empowerment, where farmers attain the capacity to innovate. The co-learning process of the project is expected to contribute to both pathways, giving insights for research projects on how to increase future adoption and adaptation.

Objectives

This research will focus on choices farmers make about the use of AEI options in the light of the different risks they face. The overall goal is to contribute to a better livelihood for farmers through increased knowledge and understanding of the suitability of AEI options.

Objective 1: To analyse the intra-household dynamics of access to resources, constraints and opportunities in relation to food and nutrition self-sufficiency and income

Hypothesis
Within a household, different units exist that have other constraints and opportunities, which translate in differences in food and nutrition self-sufficiency and income

Objective 2: To map farmers' risk management strategies and their relation to farm production, environmental and nutritional performance

Hypothesis
A higher attention to risk spreading translates to a higher diversity of farm activities

Objective 3: To capture the performance (productivity, environmental, nutritional) of the AEI options mitigating important risks, in a variable environment

Hypothesis
The benefits of a risk-taking option in a good year are counteracted by the longer-term benefits of risk-spreading

Objective 4: To study farmer's use of technologies to better understand how participatory research projects can generate meaningful insights for development

Hypotheses
AEI options that have fewer trade-offs (i.e. between labour, yield, cost-benefit) are more likely to be adopted

Study area and research context

The research takes place in 6 villages of the Koutiala district, in the 'old cotton basin' of southern Mali, within the framework of phase II of the project 'Pathways to agroecological intensification (AEI) of crop-livestock farming systems of southern Mali'. Phase I (2012-2016) focused on defining niches for sustainable intensification for different household typologies in three villages; Nitabougoro,

Nampossela and Mperesso ('old' villages). In the current phase two, the project area was extended with three villages: Signé, N'Tiesso and Deresso ('new' villages).

The AEI options were defined through co-learning with farmers using the DEED-approach (Descheemaeker et al., 2016). It follows steps of Describing, Explaining, Exploring and Designing as a pathway to a basket of AEI options for smallholder farmers to choose from (best-fit).

Methods

General: The DEED approach is the general framework. The co-learning cycle for tailoring AEI options will be continued during the project period. The results of these will feed into my research. The other general concepts cross-cutting all objectives (performance indicators, farm typology) are described below.

An overview of widely used indicators and metrics of sustainable intensification are found in Smith et al. (2017). The research will measure farm and field performance based on production, environmental and nutritional indicators. Food self-sufficiency and income from agriculture are important for farmers, and will be used as main farm performance indicators.

Especially at field level, indicators on productivity, cost-benefit, labour investment, nutritional quality and soil quality will be compared. Trade-offs between those indicators will be quantified. Useful nutrition indicators are the dietary diversity and agrobiodiversity, and for assessing ecological qualities soil organic carbon (SOM) will be used.

Heterogeneity among farms is tackled by classification according to Falconnier et al. (2015) into four farm types based on resource endowment, with defining variables being herd size, total cropped land, number of workers land and draft tools.

Objective 1: In the 6 villages 2 random farms will be sampled of every of the four farm types, so a total of 48 farms will be followed-up. Farm heads will be invited for a focus group discussion to get insight in the family structure, labour availability and resource division among household members. First step is to ascertain that household members have specific responsibilities in farm management.

Management units will be defined, based on division of labour and responsibilities among household members (e.g. Paresys et al., 2016) who distinguished individual and collectively managed fields). For a subset of the farms (continuing with 24 farms in 4 villages) a resource allocation map will be made and updated throughout the season (see below) (Dorward et al., 2007). The members of different management units will be interviewed separately about the different available resources, aspirations for agriculture, as well as what AEI options they apply. The participatory budget method is a useful tool for this (Dorward et al., 2007).

The survey results will be complemented with farm observations and performance assessments. Important (crop and animal) components will be assessed for the different intra-farm management units through a combination of survey, farmer monitoring and measured data.

Objective 2: The different risks farmers perceive and management strategies will be defined through participatory focus group discussions (with the farmers participating in objective 1) where they will identify the factors (hazards) they worry about, resulting in an overall list of possible risks and strategies (to reduce their vulnerability).

The different intra-farm management units of the sampled farms (defined in Objective 1) will identify which risks they worry most about, assigning a severity to each using a Likert-type scaling (e.g. Kisaka-Lwayo and Obi, 2012). This information will be used to score the breadth and severity of perceived risks in a community. They will also characterise "bad" and "good" years (Andrieu et al., 2015), and the strategies they apply.

To get insight how farmers react to certain events unknown at the beginning of the season, we will analyse the planned and actual practices during the cropping season. A budget plan and resource allocation map for key households is made up at the beginning of the season (cf. objective 1) and repeated to check how this resource allocation map is changing (Dorward et al., 2007) between start and end of the season. This will determine the risk management strategies coping with occurring events.

The diversity of applied strategies of a farm and within-farm unit will be linked to the available resources and overall farm income and food self-sufficiency. The link with environmental indicators will also be investigated.

Objective 3: Performance of an AEI option in relation to important risks can be assessed ex-ante using modelling tools simulating performance in a variable environment. We will investigate the performance of promising AEI options in the case of shocks or changes (hazard). Quantifying the probability of occurrence of good and bad years based on long-term weather data, will help to assess the effects of farmer decisions.

To limit the scope of the research, I will focus on promising options (based on existing information of previous research, results Objectives 1 and 2), and existing tools (e.g. NUANCES-FARMSIM (van Wijk et al., 2009) or Agricultural Production Systems sIMulator (APSIM) (Holzworth et al., 2014)) that have been tested and used already in the local context. We will use data from on-farm trials held within the project, and from long-term experiments in N'Tarla. Depending on the type of risk, the probability of the occurrence of 'bad' and 'good' years can be measured (e.g. for weather variability).

The model will simulate the effect of different AEI options that are part of a risk management strategy in scenarios of shocks/change. Most likely the APSIM model can be used for analysing the effects of intra-weather variability on crop yields at field level. The NUANCES-FARMSIM model is adequate for assessing whole farm interactions between crop and livestock components.

The LIVSIM module of FARMSIM was already calibrated for Mali by De Ridder et al. (2015) who investigated the effect of feeding regimes on milk production and on whole-farm income. Traore et al. (2017) calibrated and tested APSIM for maize and millet in southern Mali, analysing yield for climate change predictions.

Objective 4: Since 2013, farmers in the 'old' villages have been involved in co-learning DEED cycles to define and refine AEI options. Every season on-farm trials were designed with farmers and researchers and the results discussed in village meetings. From 2017 farmers will design themselves how to apply options on a 'demonstration field', where the inputs and labour are provided by the farmer. This process will be repeated every year of the project.

The choices farmers make in these demonstration fields are monitored, to get an overview of the AEI options farmers use and how they adapt them. The performance of these fields is measured. The farm management practices listed during the surveys described in objective 1 and 2 will form a second dataset that can be used in this objective.

Besides the demonstration fields, on-farm trials continue to be held every growing season. Inspired by village meetings in April 2017, the trials implemented in 2017 are about groundnut (variety x density), maize-cowpea intercropping (density x cowpea variety), millet (levels and types of fertiliser x variety), sorghum (levels and types of fertiliser x variety), cowpea (different techniques to battle insect manifestation) and soybean (fertiliser x density).

A multicriteria analysis (grain and fodder yield, labour, nutrition, cost-benefit ratio) of these trials highlights the trade-offs between different domains of sustainable intensification. As part of the DEED cycle, these results will be discussed with farmers. How this influences decision making about uptake of technologies will be tracked. The adopted practices will be monitored and compared with these trade-offs.

Overview

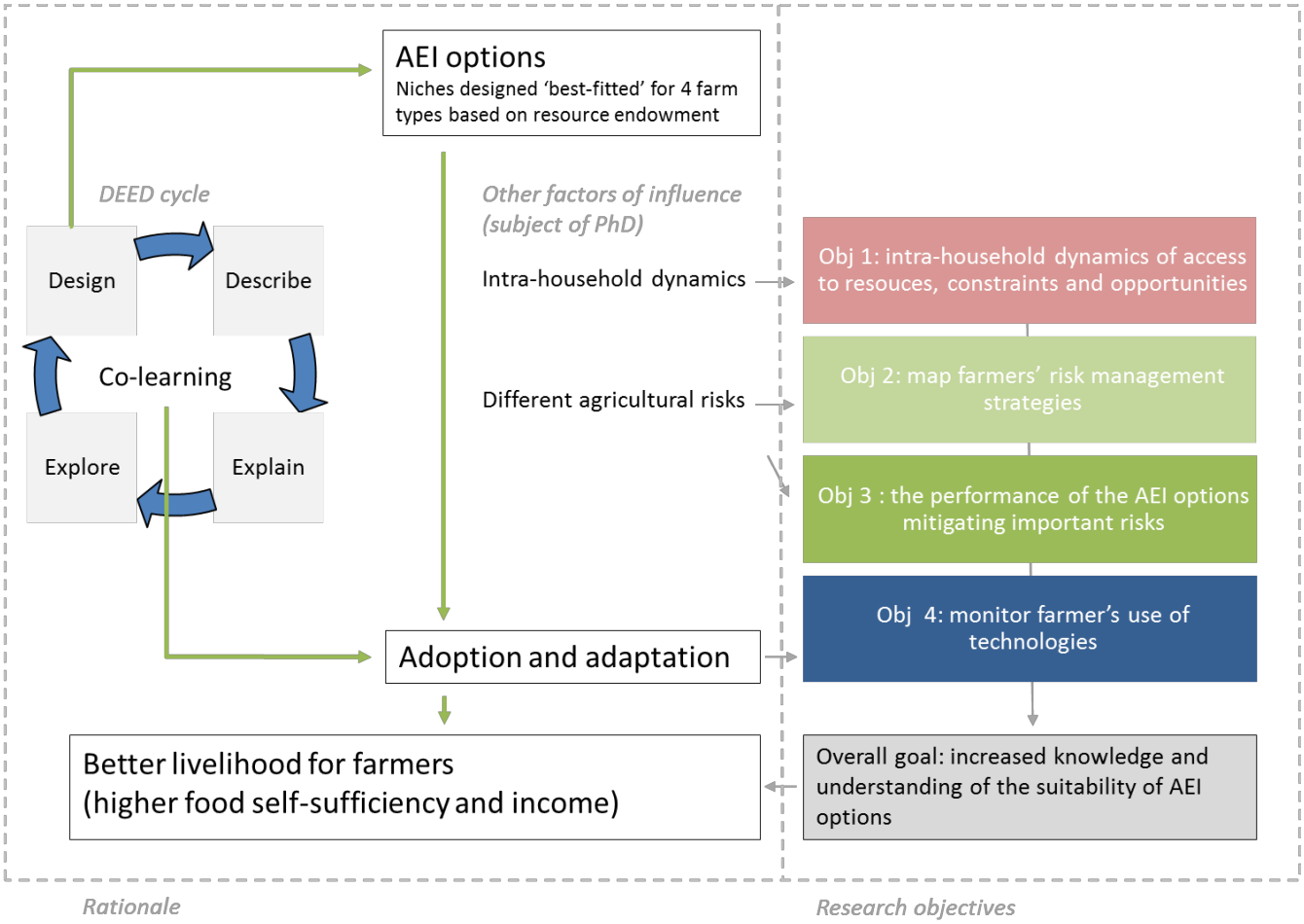

Figure 1 In an agricultural system subject to changes, AEI options designed following the DEED cycle, are promising to increase productivity in a sustainable manner. To increase the possible adoption and adaptation by farmers, the heterogeneity within farms is to be taken into account (objective 1). Adoption is also guided by the perceived risk of the options. In objective 2 and 3 I want to assess how farmers deal with risks, and how AEI options fit in their risk management strategies. For objective 4, I will look at how farmers are adopting and adapting the AEI options.

Literature

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8. TIME TABLE OF THE PROJECT AND WORK PROGRAMME

Location	Activity	16	2017				2018				2019				2020			
		dec	jfm	amj	jas	ond	jfm	amj	Jas	ond	jfm	Amj	jas	ond	jfm	apj	jas	on
General																		
Office	Develop research proposal	x	x	x														
Office	Literature study	x	x	x														
Field + Office	Farmer discussion and participatory planning next cropping season			x				x				x						
Field	Follow-up on-farm trials and demonstrations				x	x			x	x			x	x				
Office	Report results on-farm trials and demonstrations						x				x				x			
Objective 1																		
Office	Classification farm types Signé, N'Tiesso and Deresso + farm selection of all villages				x													
Field	defining within-farm units for selected farms, and design resource allocation maps				x													
Field	Follow-up farms and within-farm units (surveys, participatory budget, field and livestock monitoring)				x	x			x	x								
Office	**writing paper 1: resource endowment of 'within-farm units'**					x	x	x	x	x	x							
Objective 2																		
Field	Making list of perceived risks, Risk mapping				x	x												
Office	Analysing data perceived risks						x	x										
Field	Analyse planned and actual practices (Farm budget and resource allocation maps (cf objective 1)				x	x			x	x								
Office	**writing paper 2: mapping risk management strategies**									x	x	x						
Objective 3																		
Office	Decision on the most promising options							x	x									
Office	calibration and development models (cf data on-farm trials)						x	x	x	x	x	x						
Office	**Writing paper 3: Effects AEI option on production risks**												x	x	x	x		
Objective 4																		
Field	Monitor farmers' practices old and new villages (cf data on-farm trials)				x	x			x	x			x	x				
Office	**Writing paper 4: Adaptation of AEI options monitored**													x	x	x		
General																		
Field	Final feedback session with farmers															x		
	Write thesis and submission														x	x	x	x

Main residence: Koutiala
Main residence: Wageningen

9. SOCIETAL RELEVANCE

This research will assess the desired socio-economic context favouring agro-ecological intensification (AEI) and assess the effect of AEI options in the current socio-economic context. AEI is seen as a solution to increase productivity without further pressuring natural resources. This fits in the objective of SDG2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture.

10.DATA MANAGEMENT (242 words (max. 250))

The research is part of the second phase (2016-2019) of the project "Pathways to agroecological intensification of crop-livestock farming systems of southern Mali", funded by the McKnight foundation, and in cooperation between ICRISAT, AMEDD (Association Malienne d'éveil au Développement Durable), IER (Institut d'Economie Rurale), and WUR. All partners have their own (research) focus within in the project, but all data is shared. Also the data from phase I is available. Within the project a second PhD candidate will do research on value chain development. When possible, field activities and data collection will be synchronised and data inter-changed.

A data management plan will be regularly updated according to the PPS guidelines. Data will be stored on the M-drive, and when abroad copied to a dropbox folder. Final data will be available for the project team, and PPS group via the online PhD library.

A lot of research has been previously been done in the region, and other projects are currently running. Collaboration and possible data-exchange will be sought pro-actively. One example for potential cooperation is the Africa RISING project (Africa Research in sustainable intensification for the next generation), present in the region and with several partners, of which several CGIAR centres and WUR.

Master students that may be involved in the research will declare to provide the data that they will generate to the McKnight project partners and will, if necessary, sign a confidentiality agreement to not use the data for other projects.